**NATIONAL TECHNICAL UNIVERSITY OF ATHENS**
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**«Infrastructure and Construction Project Management»**

## Postgraduate Diploma Thesis

# *Systematic Review and Comparative Evaluation of Heavy Equipment Selection Techniques in Earthmoving Operations*

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**Abstract**

The selection and optimization of heavy machinery in earthmoving operations represents a critical decision-making challenge in the construction sector, directly influencing cost, time, and environmental impact. Despite the considerable attention this issue has received over the years, the research landscape remains fragmented, lacking a unified framework that systematically integrates diverse optimization criteria, real-world constraints, and evolving project requirements.

This study sets out to conduct a comprehensive systematic literature review (SLR) focused on methodologies used for equipment selection and fleet optimization in earthmoving operations. The primary objective was to identify dominant research trends, methodologies, success criteria, and existing gaps, thereby forming a coherent map of the current state of knowledge and highlighting opportunities for future scientific advancement.

Following the guidelines of (Kitchenham, 2007; Petersen et al., 2015) the review was structured using a systematic mapping approach. A robust search protocol was implemented, involving multiple academic databases, Boolean logic queries, defined inclusion/exclusion criteria, and staged screening using StArt software and snowballing techniques. Fifty-seven high-quality papers published between 2000 and 2025 were selected and analyzed. A multidimensional classification scheme was applied, covering research goals, methods, equipment categories, project types, publication years, and optimization objectives.

The analysis revealed that most studies focus on minimizing cost and time using simulation-based and multi-objective optimization techniques. Decision-making models, resource allocation strategies, and fuel/emissions-related criteria were also examined, although they appear less frequently. Moreover, while dump trucks and excavators are the most commonly studied machines, specialized equipment types remain underexplored. Most research is applied (evaluation/validation), highlighting a practical orientation, but suffers from limited use of real-time data, advanced AI tools, and holistic performance frameworks.

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The outcomes of this work are twofold. First, the study offers an integrated synthesis of current research, guiding scholars through a complex and often disjointed field. Second, it identifies actionable knowledge gaps, such as the limited integration of environmental and spatial efficiency criteria into decision-making models. These findings pave the way for the development of hybrid, data-driven, and multi-criteria decision support systems tailored to real-world construction contexts.

This review is significant for both researchers and practitioners. For academia, it provides a foundation for new research trajectories grounded in identified gaps. For industry, it delivers a structured overview of advanced methodologies that can enhance equipment planning, sustainability, and operational performance in infrastructure development.